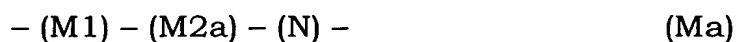


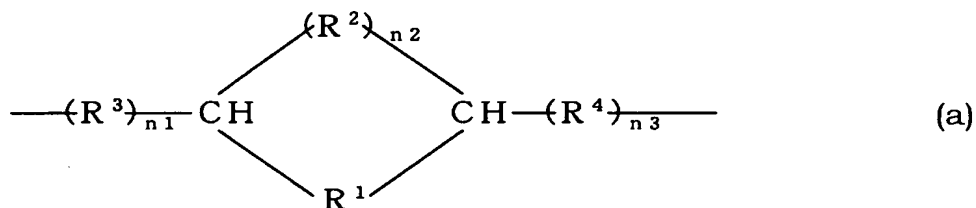
WHAT IS CLAIMED IS:

1. A fluorine-containing polymer having an aliphatic monocyclic structure in the polymer trunk chain which has a number average molecular weight of from 500 to 1,000,000 and is represented by the formula (Ma):



in which

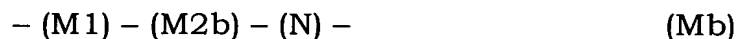
the structural unit M1 is a structural unit derived from an ethylenic monomer having 2 or 3 carbon atoms and at least one fluorine atom, the structural unit M2a is at least one structural unit which introduces an aliphatic monocyclic structure in the polymer trunk chain and is represented by the formula (a):



wherein  $\text{R}^1$  is at least one hydrocarbon group selected from the group consisting of a divalent hydrocarbon group which has 1 to 8 carbon atoms and constitutes a ring (which may be further substituted with a hydrocarbon group or a fluorine-containing alkyl group) and a divalent hydrocarbon group having ether bond which has the sum of carbon atoms and oxygen atoms of 2 to 8 and constitutes a ring (which may be

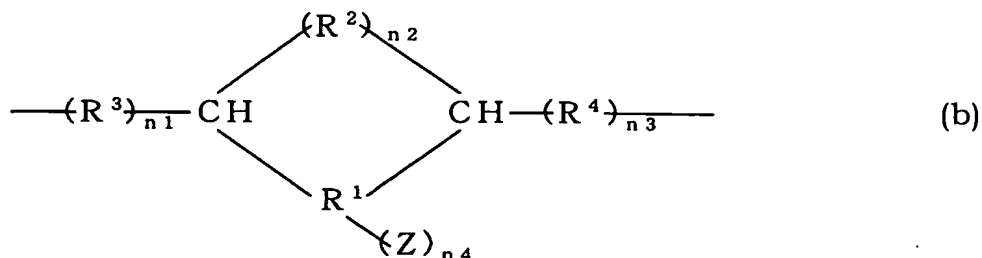
further substituted with a hydrocarbon group or a fluorine-containing alkyl group);  $R^2$  is an alkylene group which has 1 to 3 carbon atoms and constitutes a ring;  $R^3$  and  $R^4$  are the same or different and each is a divalent alkylene group having 1 or 2 carbon atoms;  $n_1$ ,  $n_2$  and  $n_3$  are  
5 the same or different and each is 0 or 1,  
the structural unit N is a structural unit derived from a monomer copolymerizable with the monomers to introduce the structural units M1 and M2a, and  
the structural units M1, M2a and N are contained in amounts of from 1  
10 to 99 % by mole, from 1 to 99 % by mole and from 0 to 98 % by mole, respectively.

2. A fluorine-containing polymer having an aliphatic monocyclic structure in the polymer trunk chain which has a number  
15 average molecular weight of from 500 to 1,000,000 and is represented by the formula (Mb):

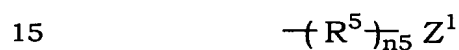


20 in which

the structural unit M1 is a structural unit derived from an ethylenic monomer having 2 or 3 carbon atoms and at least one fluorine atom,  
the structural unit M2b is at least one structural unit which introduces an aliphatic monocyclic structure in the polymer trunk chain and is  
25 represented by the formula (b):



wherein  $\text{R}^1$  is at least one hydrocarbon group selected from the group consisting of a divalent hydrocarbon group which has 1 to 8 carbon atoms and constitutes a ring (which may be further substituted with a hydrocarbon group or a fluorine-containing alkyl group) and a divalent hydrocarbon group having ether bond which has the sum of carbon atoms and oxygen atoms of 2 to 8 and constitutes a ring (which may be further substituted with a hydrocarbon group or a fluorine-containing alkyl group);  $\text{R}^2$  is an alkylene group which has 1 to 3 carbon atoms and constitutes a ring;  $\text{R}^3$  and  $\text{R}^4$  are the same or different and each is a divalent alkylene group having 1 or 2 carbon atoms;  $n1$ ,  $n2$  and  $n3$  are the same or different and each is 0 or 1;  $\text{Z}$  are the same or different and each is:



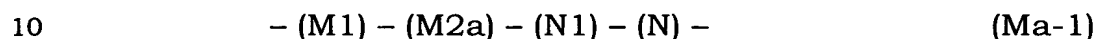
wherein  $\text{Z}^1$  is at least one functional group selected from the group consisting of OH group, COOH group, a derivative of carboxylic acid group and a functional group protected by a protective group which can convert the functional group to OH group by reaction with an acid;  $\text{R}^5$  is a divalent organic group;  $n5$  is 0 or 1;  $n4$  is an integer of from 1 to 3, the structural unit N is a structural unit derived from a monomer copolymerizable with the monomers to introduce the structural units

M1 and M2a, and

the structural units M1, M2b and N are contained in amounts of from 1 to 99 % by mole, from 1 to 99 % by mole and from 0 to 98 % by mole, respectively.

5

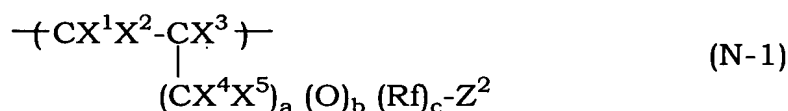
3. The fluorine-containing polymer of Claim 1, which has an aliphatic monocyclic structure in the polymer trunk chain and is represented by the formula (Ma-1):



wherein M1 and M2a are as defined in said formula (Ma),

the structural unit N1 is a structural unit derived from an ethylenic monomer represented by the formula (N-1):

15



wherein  $X^1$  and  $X^2$  are the same or different and each is H or F;  $X^3$  is H, F,  $\text{CH}_3$  or  $\text{CF}_3$ ;  $X^4$  and  $X^5$  are the same or different and each is H, F or  $\text{CF}_3$ ; Rf is a fluorine-containing alkylene group having 1 to 40 carbon atoms or a fluorine-containing alkylene group having 2 to 100 carbon atoms and ether bond; a is 0 or an integer of from 1 to 3; b and c are the same or different and each is 0 or 1;  $Z^2$  is at least one functional group selected from the group consisting of OH group, COOH group, a derivative of carboxylic acid group and a functional group protected by a protective group which can convert the functional group to OH group by

20

25

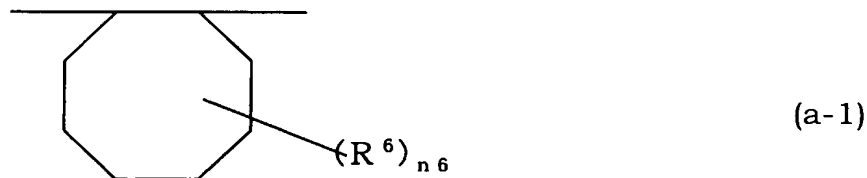
reaction with an acid,

the structural unit N is a structural unit derived from a monomer copolymerizable with the monomers to introduce the structural units M1, M2a and N1, and

- 5 the structural units M1, M2a, N1 and N are contained in amounts of from 1 to 98 % by mole, from 1 to 98 % by mole, from 1 to 98 % by mole and from 0 to 97 % by mole, respectively.

4. The fluorine-containing polymer of Claim 1, wherein in the  
10 structural unit of the formula (a),  $R^1$  is an alkylene group selected from the group consisting of a divalent hydrocarbon group having six carbon atoms (which may be further substituted with a hydrocarbon group or a fluorine-containing alkyl group) and a divalent hydrocarbon group having ether bond which has the sum of carbon atoms and oxygen  
15 atoms of six (which may be further substituted with a hydrocarbon group or a fluorine-containing alkyl group), and any of  $n_1$ ,  $n_2$  and  $n_3$  are 0.

5. The fluorine-containing polymer of Claim 4, wherein the  
20 structural unit M2a is a structural unit represented by the formula (a-1):

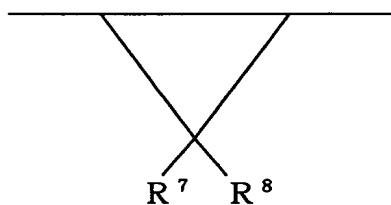


wherein  $R^6$  is selected from the group consisting of hydrogen atom, an alkyl group having 1 to 5 carbon atoms and a fluorine-containing alkyl

group which has 1 to 5 carbon atoms and may have ether bond;  $n_6$  is 0 or an integer of from 1 to 12.

6. The fluorine-containing polymer of Claim 1, wherein in the structural unit of the formula (a),  $R^1$  is a divalent alkylene group having one carbon atom (which may be further substituted with a hydrocarbon group or a fluorine-containing alkyl group), and any of  $n_1$ ,  $n_2$  and  $n_3$  are 0.

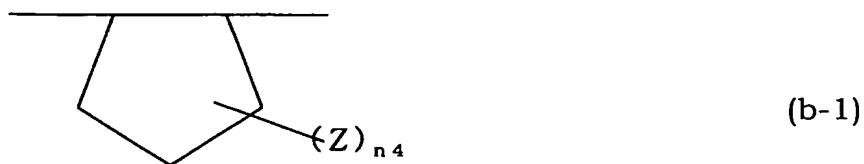
7. The fluorine-containing polymer of Claim 6, wherein the structural unit M2a is a structural unit represented by the formula (a-2):



(a-2)

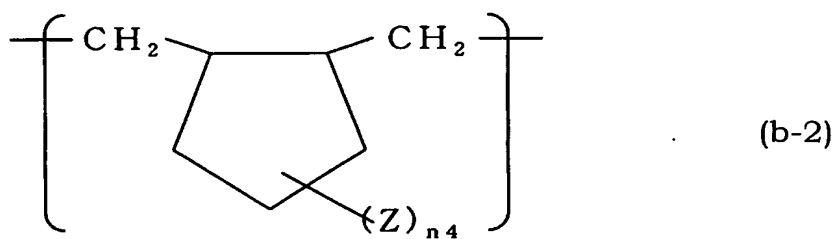
wherein  $R^7$  and  $R^8$  are the same or different and each is selected from the group consisting of hydrogen atom, an alkyl group having 1 to 5 carbon atoms or a fluorine-containing alkyl group which has 1 to 5 carbon atoms and may have ether bond.

8. The fluorine-containing polymer of Claim 2, wherein the structural unit M2b is a structural unit represented by the formula (b-1):



wherein Z and n4 are as defined in the formula (b).

9. The fluorine-containing polymer of Claim 2, wherein the structural unit M2b is a structural unit represented by the formula (b-2):

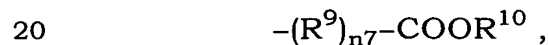


wherein Z and n4 are as defined in the formula (b).

10. The fluorine-containing polymer of Claim 2, wherein in the formula (b) representing the structural unit M2b, R<sup>5</sup> in Z is a divalent alkylene group having 1 to 30 carbon atoms or a fluorine-containing alkylene group which has 1 to 30 carbon atoms and may have ether bond.

15

11. The fluorine-containing polymer of Claim 2, wherein in the formula (b) representing the structural unit M2b, Z is represented by the formula:

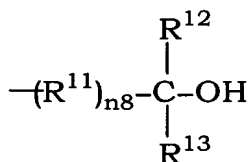


wherein  $R^9$  is an alkylene group which has 1 to 10 carbon atoms and may have ether bond or a fluorine-containing alkylene group which has 1 to 10 carbon atoms and may have ether bond;  $R^{10}$  is hydrogen atom or an alkyl group having 1 to 10 carbon atoms;  $n_7$  is 0 or 1.

5

12. The fluorine-containing polymer of Claim 2, wherein in the formula (b) representing the structural unit M2b, Z is represented by the formula:

10



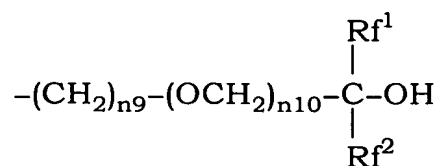
wherein  $R^{11}$  is an alkylene group which has 1 to 5 carbon atoms and may have ether bond or a fluorine-containing alkylene group which has 1 to 5 carbon atoms and may have ether bond;  $R^{12}$  and  $R^{13}$  are the same or different and each is hydrogen atom, an alkyl group having 1 to 10 carbon atoms, an aryl group having 3 to 10 carbon atoms, a fluorine-containing alkyl group which has 1 to 10 carbon atoms and may have ether bond or an aryl group which has 3 to 10 carbon atoms and may have ether bond;  $n_8$  is 0 or 1.

15

20

13. The fluorine-containing polymer of Claim 12, wherein Z is represented by the formula:





5 wherein  $\text{Rf}^1$  is a fluorine-containing alkyl group which has 1 to 10 carbon atoms and may have ether bond;  $\text{Rf}^2$  is hydrogen atom, an alkyl group having 1 to 10 carbon atoms, an aryl group having 3 to 10 carbon atoms or a fluorine-containing alkyl group which has 1 to 10 carbon atoms and may have ether bond;  $n9$  is 0 or an integer of from 1 to 5;  $n10$   
10 is 0 or 1.

14. The fluorine-containing polymer of Claim 13, wherein  $\text{Rf}^1$  and  $\text{Rf}^2$  are the same or different and each is a perfluoroalkyl group having 1 to 5 carbon atoms.

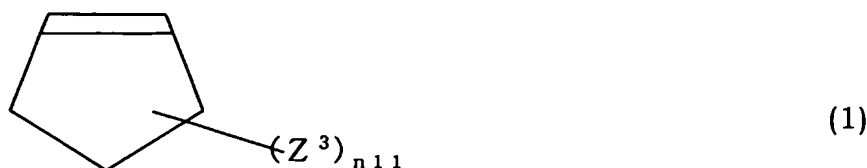
15

15. The fluorine-containing polymer of Claim 1, wherein the structural unit M1 is a structural unit derived from tetrafluoroethylene or chlorotrifluoroethylene.

20

16. The fluorine-containing polymer of Claim 2, wherein the structural unit M1 is a structural unit derived from tetrafluoroethylene or chlorotrifluoroethylene.

17. A fluorine-containing unsaturated cyclic compound  
25 represented by the formula (1):



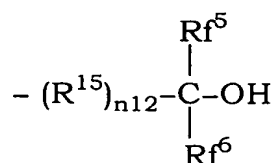
wherein  $Z^3$  are the same or different and each is  $-Rf^3-Z^4$ , in which  $Z^4$  is at least one functional group selected from the group consisting of OH group, COOH group, a derivative of carboxylic acid group and a functional group protected by a protective group which can convert the functional group to OH group by reaction with an acid;  $Rf^3$  is a fluorine-containing alkylene group which has 1 to 30 carbon atoms and may have ether bond;  $n+1$  is an integer of from 1 to 4.

18. The fluorine-containing unsaturated cyclic compound of Claim 17, wherein in the formula (1),  $Z^3$  is represented by the formula:



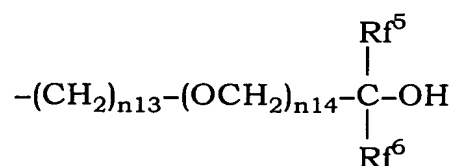
wherein  $Rf^4$  is a perfluoroalkylene group which has 1 to 10 carbon atoms and may have ether bond;  $R^{14}$  is hydrogen atom or an alkyl group having 1 to 10 carbon atoms.

19. The fluorine-containing unsaturated cyclic compound of Claim 17, wherein in the formula (1),  $Z^3$  is represented by the formula:



wherein R<sup>15</sup> is an alkylene group which has 1 to 5 carbon atoms and may have ether bond or a fluorine-containing alkylene group which has 1 to 5 carbon atoms and may have ether bond; Rf<sup>5</sup> is a fluorine-containing alkyl group which has 1 to 10 carbon atoms and may have ether bond; Rf<sup>6</sup> is hydrogen atom, an alkyl group having 1 to 10 carbon atoms or a fluorine-containing alkyl group which has 1 to 10 carbon atoms and may have ether bond; n12 is 0 or 1.

20. The fluorine-containing unsaturated cyclic compound of Claim 19, wherein Z<sup>3</sup> is represented by the formula:



wherein Rf<sup>5</sup> and Rf<sup>6</sup> are as defined in said formula; n13 is 0 or an integer of from 1 to 5; n14 is 0 or 1.

21. The fluorine-containing unsaturated cyclic compound of Claim 19, wherein Rf<sup>5</sup> and Rf<sup>6</sup> are the same or different and each is a perfluoroalkyl group having 1 to 5 carbon atoms.

22. A photoresist composition which comprises:  
 (A-1) a fluorine-containing polymer having OH group, COOH group and/or a group which can be dissociated by an acid and converted to OH group or COOH group,  
 (B) a photoacid generator and

(C) a solvent,

in which the fluorine-containing polymer (A-1) is a polymer comprising a structural unit derived from a fluoroolefin and a structural unit derived from a monomer introducing an aliphatic monocyclic structure in the  
5 polymer trunk chain.

23. The photoresist composition of Claim 22, wherein said fluorine-containing polymer (A-1) is a fluorine-containing polymer of Claim 3 having an aliphatic monocyclic structure in a trunk chain  
10 thereof which has, as a functional group, OH group or COOH group and/or a functional group protected by a protective group which can convert the functional group to OH group or COOH group by reaction with an acid.

15 24. The photoresist composition of Claim 22, wherein said fluorine-containing polymer (A-1) is a fluorine-containing polymer of Claim 2 having an aliphatic monocyclic structure in a trunk chain thereof which has, as a functional group, OH group or COOH group and/or a functional group protected by a protective group which can  
20 convert the functional group to OH group or COOH group by reaction with an acid.

25 25. A photoresist composition which comprises:  
(A-2) a fluorine-containing polymer having OH group which has recurring units of an aliphatic monocyclic structure in the polymer trunk chain, in which OH group or a moiety having OH group is bonded to the carbon atom constituting the aliphatic monocyclic structure,

(B) a photoacid generator and

(C) a solvent,

in which when in the recurring units of aliphatic monocyclic structure of the fluorine-containing polymer (A-2), the carbon atom bonded to OH group is named the first carbon atom and a structure consisting of the first carbon atom up to the neighboring fourth carbon atom is assumed to be a model structure, the model structure having OH group satisfies Equation 1:

10 
$$\Delta H = H(M-O^-) + 200 - H(M-OH) \leq 75 \quad (\text{Equation 1})$$

wherein  $H(M-OH)$  is a produced enthalpy of the model structure,  $H(M-O^-)$  is a produced enthalpy of the model structure after dissociation of the OH group and a produced enthalpy of hydrogen ion is assumed to be a constant of 200 kJ/mol.

26. The photoresist composition of Claim 25, wherein the model structure having OH group of the fluorine-containing polymer (A-2) satisfies Equation 2:

20 
$$\Delta H = H(M-O^-) + 200 - H(M-OH) \leq 70 \quad (\text{Equation 2}).$$

27. A photoresist composition which comprises:

(A-3) a fluorine-containing polymer having OH group which has recurring units of an aliphatic monocyclic structure in the polymer trunk chain, in which OH group or a moiety having OH group is bonded to the carbon atom constituting the aliphatic monocyclic structure,

(B) a photoacid generator and

(C) a solvent,

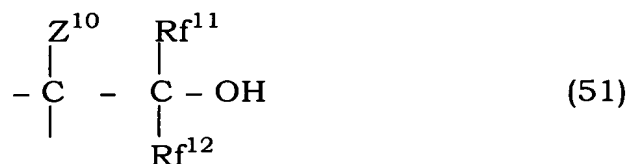
in which the recurring units of the aliphatic monocyclic structure of the fluorine-containing polymer (A-3) have a structure represented by the

5 formula (50):



10 wherein Rf<sup>11</sup> is a perfluoroalkyl group having 1 to 20 carbon atoms; Z<sup>10</sup> is fluorine atom or a perfluoroalkyl group having 1 to 20 carbon atoms.

28. The photoresist composition of Claim 27, wherein the structure represented by the formula (50) in the recurring units of the  
15 aliphatic monocyclic structure of the fluorine-containing polymer (A-3) is a structure represented by the formula (51):



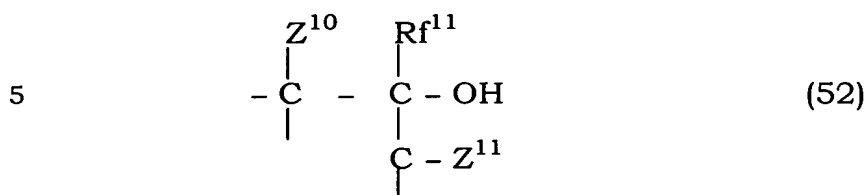
20

wherein Rf<sup>11</sup> and Rf<sup>12</sup> are the same or different and each is a perfluoroalkyl group having 1 to 20 carbon atoms; Z<sup>10</sup> is fluorine atom or a perfluoroalkyl group having 1 to 20 carbon atoms.

25

29. The photoresist composition of Claim 27, wherein the structure represented by the formula (50) in the recurring units of the

aliphatic monocyclic structure of the fluorine-containing polymer (A-3) is a structure represented by the formula (52):



wherein Rf<sup>11</sup> is a perfluoroalkyl group having 1 to 20 carbon atoms; Z<sup>10</sup> and Z<sup>11</sup> are the same or different and each is fluorine atom or a perfluoroalkyl group having 1 to 20 carbon atoms.

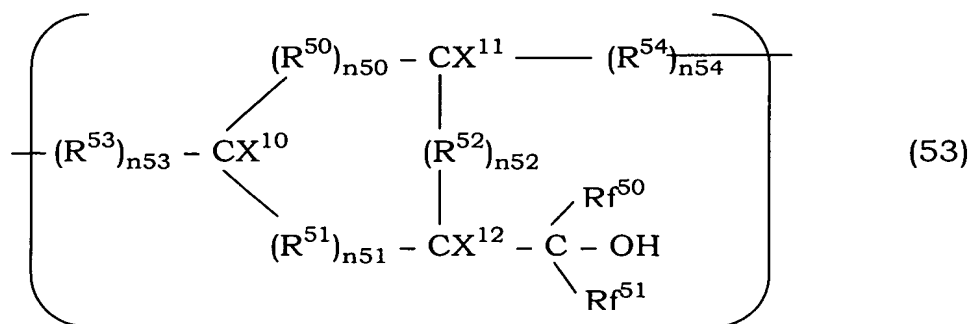
30. A photoresist composition which comprises:

(A-5) a fluorine-containing polymer having OH group which has recurring units of an aliphatic monocyclic structure in the polymer trunk chain, in which OH group or a moiety having OH group is bonded to the carbon atom constituting the aliphatic monocyclic structure,

(B) a photoacid generator and

(C) a solvent,

in which the fluorine-containing polymer (A-5) is a polymer having a structural unit represented by the formula (53):

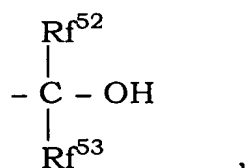


wherein  $Rf^{50}$  and  $Rf^{51}$  are the same or different and each is a perfluoroalkyl group having 1 to 20 carbon atoms;  $X^{10}$  and  $X^{11}$  are the same or different and each is H, F, an alkyl group having 1 to 20 carbon atoms or a fluorine-containing alkyl group which has 1 to 20 carbon atoms and may have ether bond;  $X^{12}$  is hydrogen atom, fluorine atom, an alkyl group having 1 to 20 carbon atoms, a fluorine-containing alkyl group which has 1 to 20 carbon atoms and may have ether bond, OH group or a group represented by the formula:



wherein  $Rf^{52}$  and  $Rf^{53}$  are the same or different and each is a perfluoroalkyl group having 1 to 20 carbon atoms;  $R^{50}$  is at least one selected from an alkylene group or fluorine-containing alkylene group which has 1 to 3 carbon atoms and constitutes a ring;  $R^{51}$  and  $R^{52}$  are the same or different and each is at least one selected from a divalent hydrocarbon group which has 1 to 7 carbon atoms and constitutes a ring, oxygen atom, a divalent hydrocarbon group having ether bond which has the sum of oxygen atoms and carbon atoms of 2 to 7 and constitutes a ring, a divalent fluorine-containing alkylene group which has 1 to 7 carbon atoms and constitutes a ring or a divalent fluorine-containing alkylene group having ether bond which has the sum of oxygen atoms and carbon atoms of 2 to 7 and constitutes a ring; the sum of carbon atoms constituting a trunk chain in  $R^{51}$  and  $R^{52}$  is not more than 7, and OH group or a group represented by the formula:





5 wherein  $\text{Rf}^{52}$  and  $\text{Rf}^{53}$  are as defined above, may be bonded to any of carbon atoms in  $\text{R}^{51}$ ;  $\text{R}^{53}$  and  $\text{R}^{54}$  are the same or different and each is a divalent alkylene group having 1 or 2 carbon atoms or a divalent fluorine-containing alkylene group having 1 or 2 carbon atoms;  $n_{50}$ ,  $n_{51}$ ,  $n_{52}$ ,  $n_{53}$  and  $n_{54}$  are the same or different and each is 0 or 1.

10

31. A photoresist composition which comprises:

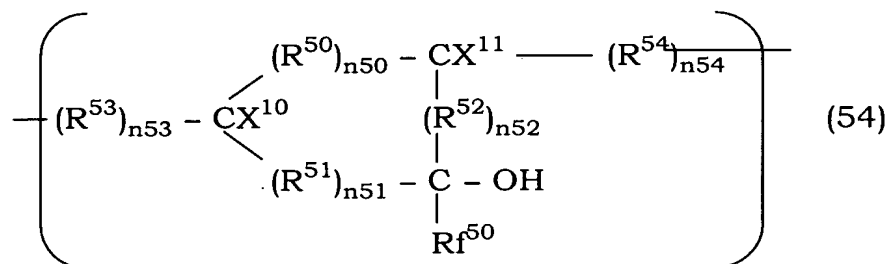
(A-5) a fluorine-containing polymer having OH group which has recurring units of an aliphatic monocyclic structure in the polymer trunk chain, in which OH group or a moiety having OH group is bonded  
15 to the carbon atom constituting the aliphatic monocyclic structure,

(B) a photoacid generator and

(C) a solvent,

in which the fluorine-containing polymer (A-5) is a polymer having a structural unit represented by the formula (54):

20

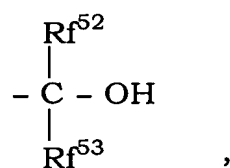


25

wherein  $\text{Rf}^{50}$  is a perfluoroalkyl group having 1 to 20 carbon atoms;  $\text{X}^{10}$  and  $\text{X}^{11}$  are the same or different and each is H, F, an alkyl group having

1 to 20 carbon atoms or a fluorine-containing alkyl group which has 1 to 20 carbon atoms and may have ether bond; R<sup>50</sup> is at least one selected from an alkylene group or fluorine-containing alkylene group which has 1 to 3 carbon atoms and constitutes a ring; R<sup>51</sup> and R<sup>52</sup> are the same or different and each is at least one selected from a divalent hydrocarbon group which has 1 to 7 carbon atoms and constitutes a ring, oxygen atom, a divalent hydrocarbon group having ether bond which has the sum of oxygen atoms and carbon atoms of 2 to 7 and constitutes a ring, a divalent fluorine-containing alkylene group which has 1 to 7 carbon atoms and constitutes a ring or a divalent fluorine-containing alkylene group having ether bond which has the sum of oxygen atoms and carbon atoms of 2 to 7 and constitutes a ring; the sum of carbon atoms constituting a trunk chain in R<sup>51</sup> and R<sup>52</sup> is not more than 7, and OH group or a group represented by the formula:

15



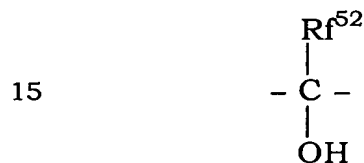
20 wherein Rf<sup>52</sup> and Rf<sup>53</sup> are the same or different and each is a perfluoroalkyl group having 1 to 20 carbon atoms, may be bonded to any of carbon atoms in R<sup>51</sup>; R<sup>53</sup> and R<sup>54</sup> are the same or different and each is a divalent alkylene group having 1 or 2 carbon atoms or a divalent fluorine-containing alkylene group having 1 or 2 carbon atoms; n<sub>50</sub>, n<sub>51</sub>, n<sub>52</sub>, n<sub>53</sub> and n<sub>54</sub> are the same or different and each is 0 or 1.

32. The photoresist composition of Claim 30, wherein in the

formula (53),  $X^{12}$  is fluorine atom or a perfluoroalkyl group having 1 to 20 carbon atoms.

33. The photoresist composition of Claim 31, wherein in  $R^{51}$   
5 or  $R^{52}$  of said formula (54), at least one of fluorine atom or a perfluoroalkyl group having 1 to 20 carbon atoms is bonded to at least one of neighboring carbon atoms of the carbon atom bonded to OH group.

10 34. The photoresist composition of Claim 31, wherein in the formula (54), the structure of  $R^{51}$  contains at least one structural unit represented by the formula:



wherein  $R^{52}$  is as defined above.

20 35. A photoresist composition which comprises:  
(A-4) a fluorine-containing polymer having a functional group protected by a protective group which can convert the functional group to OH group by reaction with an acid,  
(B) a photoacid generator and  
25 (C) a solvent,  
in which the fluorine-containing polymer (A-4) is any one of the fluorine-containing polymers of Claim 25, in which the polymers have a

functional group protected by the protective group which protects OH group contained in the recurring unit of aliphatic monocyclic structure of the polymer.

5                    36. A photoresist composition which comprises:

(A-4) a fluorine-containing polymer having a functional group protected by a protective group which can convert the functional group to OH group by reaction with an acid,

(B) a photoacid generator and

10 (C) a solvent,

in which the fluorine-containing polymer (A-4) is any one of the fluorine-containing polymers of Claim 27, in which the polymers have a functional group protected by the protective group which protects OH group contained in the recurring unit of aliphatic monocyclic structure  
15 of the polymer.

37. A photoresist composition which comprises:

(A-4) a fluorine-containing polymer having a functional group protected by a protective group which can convert the functional group to OH  
20 group by reaction with an acid,

(B) a photoacid generator and

(C) a solvent,

in which the fluorine-containing polymer (A-4) is any one of the fluorine-containing polymers of Claim 30, in which the polymers have a functional group protected by the protective group which protects OH  
25 group contained in the recurring unit of aliphatic monocyclic structure of the polymer.

38. A photoresist composition which comprises:

(A-4) a fluorine-containing polymer having a functional group protected by a protective group which can convert the functional group to OH group by reaction with an acid,

5 (B) a photoacid generator and

(C) a solvent,

in which the fluorine-containing polymer (A-4) is any one of the fluorine-containing polymers of Claim 31, in which the polymers have a functional group protected by the protective group which protects OH  
10 group contained in the recurring unit of aliphatic monocyclic structure of the polymer.

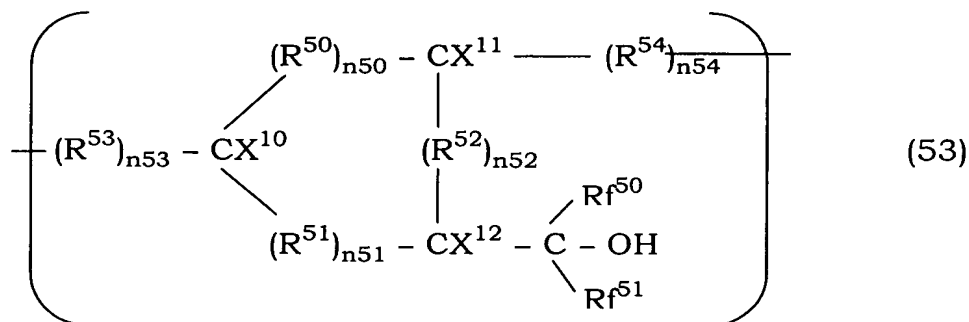
39. A fluorine-containing polymer having a number average molecular weight of from 500 to 1,000,000 represented by the formula

15 (61):



in which M3-1 is a structural unit represented by the formula (53):

20

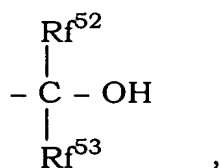


25 wherein  $Rf^{50}$  and  $Rf^{51}$  are the same or different and each is a

perfluoroalkyl group having 1 to 20 carbon atoms;  $X^{10}$  and  $X^{11}$  are the same or different and each is H, F, an alkyl group having 1 to 20 carbon atoms or a fluorine-containing alkyl group which has 1 to 20 carbon atoms and may have ether bond;  $X^{12}$  is hydrogen atom, fluorine atom, an  
 5 alkyl group having 1 to 20 carbon atoms, a fluorine-containing alkyl group which has 1 to 20 carbon atoms and may have ether bond, OH group or a group represented by the formula:



wherein  $Rf^{52}$  and  $Rf^{53}$  are the same or different and each is a perfluoroalkyl group having 1 to 20 carbon atoms;  $R^{50}$  is at least one  
 15 selected from an alkylene group or fluorine-containing alkylene group which has 1 to 3 carbon atoms and constitutes a ring;  $R^{51}$  and  $R^{52}$  are the same or different and each is at least one selected from a divalent hydrocarbon group which has 1 to 7 carbon atoms and constitutes a ring, oxygen atom, a divalent hydrocarbon group having ether bond  
 20 which has the sum of oxygen atoms and carbon atoms of 2 to 7 and constitutes a ring, a divalent fluorine-containing alkylene group which has 1 to 7 carbon atoms and constitutes a ring or a divalent fluorine-containing alkylene group having ether bond which has the sum of oxygen atoms and carbon atoms of 2 to 7 and constitutes a ring; the sum  
 25 of carbon atoms constituting a trunk chain in  $R^{51}$  and  $R^{52}$  is not more than 7, and OH group or a group represented by the formula:



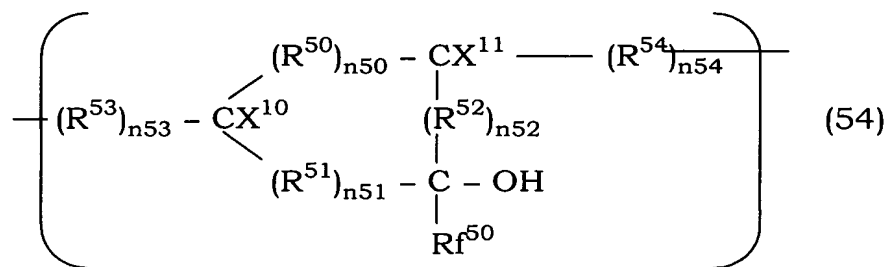
- 5 wherein  $\text{Rf}^{52}$  and  $\text{Rf}^{53}$  are as defined above, may be bonded to any of carbon atoms in  $\text{R}^{51}$ ;  $\text{R}^{53}$  and  $\text{R}^{54}$  are the same or different and each is a divalent alkylene group having 1 or 2 carbon atoms or a divalent fluorine-containing alkylene group having 1 or 2 carbon atoms;  $n_{50}$ ,  $n_{51}$ ,  $n_{52}$ ,  $n_{53}$  and  $n_{54}$  are the same or different and each is 0 or 1,
- 10 N3-1 is a structural unit derived from a monomer copolymerizable with the monomer to introduce the structural unit M3-1, and the structural units M3-1 and N3-1 are contained in amounts of from 0.1 to 100 % by mole and from 0 to 99.9 % by mole, respectively.

- 15 40. A fluorine-containing polymer having a number average molecular weight of from 500 to 1,000,000 represented by the formula (61):



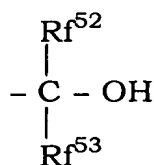
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in which M3-1 is a structural unit represented by the formula (54):



25

wherein  $Rf^{50}$  is a perfluoroalkyl group having 1 to 20 carbon atoms;  $X^{10}$  and  $X^{11}$  are the same or different and each is H, F, an alkyl group having 1 to 20 carbon atoms or a fluorine-containing alkyl group which has 1 to 20 carbon atoms and may have ether bond;  $R^{50}$  is at least one selected from an alkylene group or fluorine-containing alkylene group which has 1 to 3 carbon atoms and constitutes a ring;  $R^{51}$  and  $R^{52}$  are the same or different and each is at least one selected from a divalent hydrocarbon group which has 1 to 7 carbon atoms and constitutes a ring, oxygen atom, a divalent hydrocarbon group having ether bond which has the sum of oxygen atoms and carbon atoms of 2 to 7 and constitutes a ring, a divalent fluorine-containing alkylene group which has 1 to 7 carbon atoms and constitutes a ring or a divalent fluorine-containing alkylene group having ether bond which has the sum of oxygen atoms and carbon atoms of 2 to 7 and constitutes a ring; the sum of carbon atoms constituting a trunk chain in  $R^{51}$  and  $R^{52}$  is not more than 7, and OH group or a group represented by the formula:



wherein  $Rf^{52}$  and  $Rf^{53}$  are the same or different and each is a perfluoroalkyl group having 1 to 20 carbon atoms, may be bonded to any of carbon atoms in  $R^{51}$ ;  $R^{53}$  and  $R^{54}$  are the same or different and each is a divalent alkylene group having 1 or 2 carbon atoms or a divalent fluorine-containing alkylene group having 1 or 2 carbon atoms;  $n_{50}$ ,  $n_{51}$ ,  $n_{52}$ ,  $n_{53}$  and  $n_{54}$  are the same or different and each is 0 or 1,



N3-1 is a structural unit derived from a monomer copolymerizable with the monomer to introduce the structural unit M3-1, and the structural units M3-1 and N3-1 are contained in amounts of from 0.1 to 100 % by mole and from 0 to 99.9 % by mole, respectively.

5

41. The fluorine-containing polymer of Claim 39, wherein in the formula (53),  $X^{12}$  is fluorine atom or a perfluoroalkyl group having 1 to 20 carbon atoms.

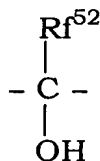
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42. The fluorine-containing polymer of Claim 40, wherein in  $R^{51}$  and  $R^{52}$  of the formula (54), at least one of fluorine atom or a perfluoroalkyl group having 1 to 20 carbon atoms is bonded to at least one of neighboring carbon atoms of the carbon atom bonded to OH group.

15

43. The fluorine-containing polymer of Claim 40, wherein in the formula (54), the structure of  $R^{51}$  contains at least one structural unit represented by the formula:

20



wherein  $R^{52}$  is as defined above.

25

44. The fluorine-containing polymer of Claim 39, wherein when in the structural unit M3-1, the carbon atom bonded to OH group

is named the first carbon atom and a structure consisting of the first carbon atom up to the neighboring fourth carbon atom is assumed to be a model structure, the model structure having OH group satisfies Equation 1:

5

$$\Delta H = H(M-O^-) + 200 - H(M-OH) \leq 75 \quad (\text{Equation 1})$$

wherein  $H(M-OH)$  is a produced enthalpy of the model structure,  $H(M-O^-)$  is a produced enthalpy of the model structure after dissociation of the OH group and a produced enthalpy of hydrogen ion is assumed to be a constant of 200 kJ/mol.

45. The fluorine-containing polymer of Claim 40, wherein when in the structural unit M3-1, the carbon atom bonded to OH group is named the first carbon atom and a structure consisting of the first carbon atom up to the neighboring fourth carbon atom is assumed to be a model structure, the model structure having OH group satisfies Equation 1:

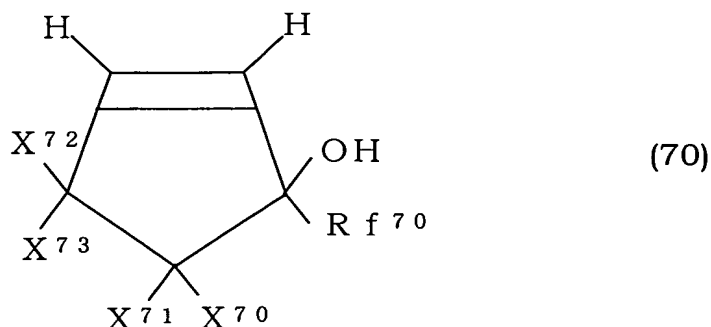
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$$\Delta H = H(M-O^-) + 200 - H(M-OH) \leq 75 \quad (\text{Equation 1})$$

wherein  $H(M-OH)$  is a produced enthalpy of the model structure,  $H(M-O^-)$  is a produced enthalpy of the model structure after dissociation of the OH group and a produced enthalpy of hydrogen ion is assumed to be a constant of 200 kJ/mol.

46. A fluorine-containing cyclopentene having OH group

represented by the formula (70):



wherein  $Rf^{70}$  is a perfluoroalkyl group having 1 to 20 carbon atoms;  $X^{70}$  is fluorine atom or a perfluoroalkyl group having 1 to 20 carbon atoms;  
 5  $X^{71}$  is hydrogen atom, fluorine atom, a hydrocarbon group having 1 to 20 carbon atoms or a perfluoroalkyl group having 1 to 20 carbon atoms;  $X^{72}$  is hydrogen atom, fluorine atom, OH group, a hydrocarbon group having 1 to 20 carbon atoms or a perfluoroalkyl group having 1 to 20 carbon atoms;  $X^{73}$  is hydrogen atom, fluorine atom, a hydrocarbon group having  
 10 1 to 20 carbon atoms or a perfluoroalkyl group having 1 to 20 carbon atoms; when  $X^{72}$  is OH group,  $X^{73}$  is not fluorine atom.

47. The fluorine-containing cyclopentene having OH group of Claim 46, wherein in the formula (70), both of  $X^{70}$  and  $X^{71}$  are fluorine  
 15 atoms or perfluoroalkyl groups having 1 to 20 carbon atoms.

48. The fluorine-containing cyclopentene having OH group of Claim 46, wherein in the formula (70),  $X^{72}$  is OH group and  $X^{73}$  is a perfluoroalkyl group having 1 to 20 carbon atoms.